Application of a Model for Coupled Multiphase Fluid Flow, Heat Transport, and Mechanical Deformation to Surface Deformations Associated with Volcanic Activities

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A model for analysis of coupled multiphase fluid flow, heat transport, and mechanical deformation (TOUGH-FLAC) is applied to study the role of hydrothermal circulation in ground deformation episodes (associated with volcanic activities) at the Phlegrean Fields in Italy. We calculate the effects of an increased magmatic degassing on the deformation of a shallow elastic porous medium. Our results show that a short period of increased release of fluids from the magma chamber into the shallow hydrothermal system can represent a potential trigger for slow ground deformations, through the effects of coupled hydrologic-mechanical (effective stress) and thermal-mechanical (thermal expansion) processes. The comparison between these preliminary results and field data shows that the model captures both the temporal evolution of ground displacement and the compositional variations of fumarolic gas recently observed at the Phlegrean Fields. Such ground deformations are usually interpreted as the product of an incremental pressure increase at the magma chamber level. The results of this analysis also suggest that the movements of hot hydrothermal fluids in the shallow system play an important role in the deformation process.